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A simulation of aerosols over Green Sahara in Mid-Holocene period with prescribed vegetation covers

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INTRODUCTION

A Green Sahara, instead of present desert Sahara, existed in the North-Africa during the early- to mid-Holocene (11,000 to 5,000 years before present) as suggested by comprehensive paleoproxy data and studies (Hoelzmann et al., 1998; Hély et al., 2014).

Several factors are considered to play a role in establishing such a Green Sahara in a cause-effect or a coupled way. For example, the summer insolation in the Northern Hemisphere was larger than today due to the orbital shifting, which resulted in a stronger West African Monsoon (WAM) and a northward West African rain belt. As a consequence, more vegetation were able to grow and more lakes appeared, which induce more precipitation and could further enhance WAM.

These coupled and complex processes have already been simulated by different models (e.g. Egerer et al., 2018). On the basis of previous model works we aim to provide a more comprehensive simulation of the Mid-Holocene period with focus on the Green Sahara area, which can provide a reliable paleoclimate to help further studies, e.g. how human migrates during the Holocene.

In this preliminary study the Earth system model EC-Earth will be used to simulate how the interactions between climate and vegetation can affect dust load in the air. EC-Earth is developed jointly by 28 European research institutes (Hazeleger et al., 2012). EC-Earth comprises of the atmosphere model IFS (Integrated Forecasting Model), ocean model NEMO with the coupled ice model LIM, and vegetation model LPJ-GUESS, coupled with OASIS coupler. Aerosols and chemistry are included through the global chemistry-transport model TM5.

The EC-Earth model will be applied to early-to-mid-Holocene climate in several different configurations, including forcings from orbital changes, vegetation cover and aerosol components. The forcings will be applied either individually or together to analyze synergistic interactions and feedbacks.

As a start, we simulated the global dust load concentrations with different vegetation covers according to Lu et al. (2018), representing pre-industrial vegetation, Mid-Holocene vegetation forced by insolation and greenhouse gas concentration of 6000 years before present (BP) with pre-industrial vegetation and dust concentration (MH), and with prescribed Green Sahara vegetation and reduced dust concentration (MH_gsrd).

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